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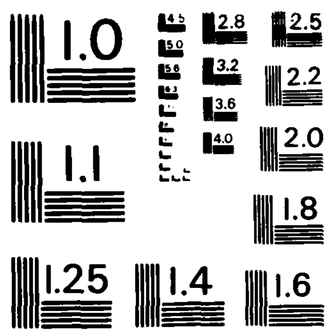

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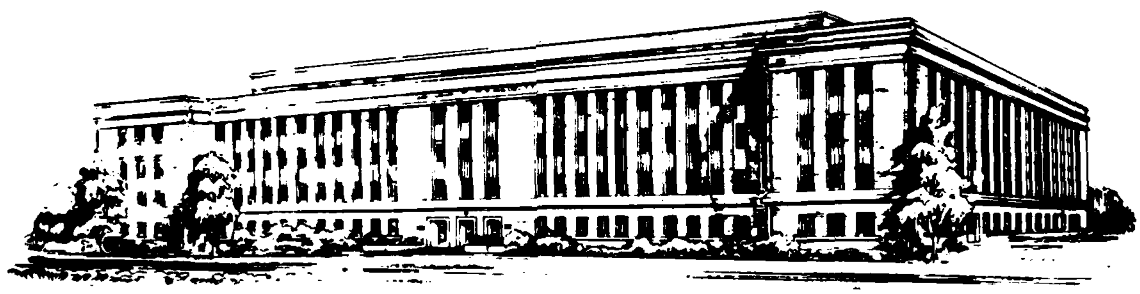
AIR REFUELING: THE KC-10 CONNECTION



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This paper attempts to quantify the contribution of the KC-10 to Air Force war-fighting capabilities. The methods used in the study included a computerized KC-10 flight planning model and the Air Force mission area analysis multi-attribute utility computer model. The study was limited to general ptupose force support because of the inability of the KC-10 to withstand the effects of a nuclear explosion.

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MOBILIZATION STUDIES PROGRAM REPORT

AIR REFUELING: THE KC-10 CONNECTION

by

GREGORY A. KUEHNER, LTC, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY
IN
FULFILLMENT OF THE RESEARCH
REQUIREMENT

RESEARCH SUPERVISOR: LTC STEVE KNODE, USAF

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ABSTRACT OF STUDENT RESEARCH REPORT
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ABSTRACT

Problem Statement: This paper attempts to quantify the contribution of the KC-10 to Air Force warfighting capabilities. The methods used in the study included a computerized KC-10 flight planning model and the Air Force mission area analysis multi-attribute utility computer model. The study was limited to general purpose force support because of the inability of the KC-10 to withstand the effects of a nuclear explosion.

Findings/Conclusions:

1. The multi-attribute utility models are good methods for quantifying contributions of a single element in a multi-element force.

2) A force of 68 KC-10s can provide a capability to deploy and sustain a typical tactical fighter wing including C-5 and C-141 supply logistic support.

3) Computer support is essential to handle a large model.

Recommendations:

1. The capabilities and deficiencies of the KC-10 must be continuously updated and redefined to optimize the contribution of the KC-10 to Air Force combat readiness.

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EXECUTIVE SUMMARY

The KC-10 was purchased to provide the Air Force with a large air refueling tanker aircraft that also possesses an outsized cargo carrying capability. The requirement for an aircraft like the KC-10 grew out of the shift away from forward-based combat forces to CONUS-based combat forces that can be rapidly deployed. The shift to CONUS-based forces has placed a heavy burden on air refueling and cargo airlift capability. Because of ever increasing needs for both tactical fighter air refueling and now for airlifter refueling in the refuelable C-141B and the C-5A, the KC-10 was optimized for the tanker role rather than the airlift of cargo. However, the contribution of the KC-10 as an air refueling tanker needs to be adequately quantified.

In order to quantify the contribution of the KC-10 toward executing the Air Force mission, a hierarchical multi-attribute utility model was constructed. Analysis of the model was done on the computer program developed by National Defense Decision Systems and by the Headquarters, Air Force Mission Area Analysis Tree Processor computer program. The KC-10's air refueling capabilities were analyzed in NATO, Southwest Asia, and Pacific operating theaters against F-4Es, F-15s, F-111s, B-52s, E-3As, C-141Bs, and C-5As. In analyzing the air refueling requirements for these aircraft, a KC-10 computer flight plan was used to determine the number of KC-10s that would be needed to deploy the various types of receiver aircraft to the three operating theaters. (See Chapter IV, page 20 for receiver to tanker ratio.)

Using the Air Force Mission Area Analysis and KC-10 computer flight planning, a deployment of a four-squadron F-15 wing, an F-111 squadron, twelve B-52s, and supporting E-3A aircraft and airlifters to Southweat Asia was analyzed. Analysis showed that the entire fleet of 68 KC-10A aircraft would be required to deploy the units involved and provide a portion of the first day's airlift. Thirteen KC-10s, plus spares, would be required to provide daily refueling support for resupply airlifters. Additional KC-10s would be required to deploy replacement aircraft. Because one theater of operations utilizes all or a portion of the proposed fleet of KC-10s for the deployment and resupply missions, the employment air refueling tasks would be handled by KC-135s. Simultaneous operations in other theaters and withholding tankers to support strategic nuclear bombers would also exacerbate the demand for air refueling tankers.

While this study is by no means exhaustive, the trends toward air refueling remaining the primary mission of the KC-10 seem clearly demonstrated, and the design of the aircraft was correctly optimized for the air refueling mission. Multi-attribute utility theory seems well suited to quantifying air refueling contributions to accomplishing Air Force missions, and additional studies are recommended.

CHAPTER I

AIR REFUELING: THE KC-10 CONNECTION

The first significant operational use of air refueling occurred during the first week of January 1929, when a U.S. Army Fokker C-1 monoplane was kept aloft for over six days. The Fokker C-1 was called the Question Mark, and its mission objective was to set an endurance record. The flight took place on the coast of California between Santa Monica and San Diego. The mission was terminated near Burbank when one of the Fokker's three engines failed after a flight time of 150 hours and 40 minutes. The air refueling for the Question Mark's misson was handled by a Fokker C-2 single engine biplane. The Question Mark was refueled 43 times (nine times at night) for a total refueling time (coupled flight) of five and one-half hours. The refueling apparatus was a fire hose borrowed from a local fire station and was lowered by hand from the tanker to the receiver. In all, 5,660 gallons of aviation gas and 245 gallons of oil were transferred.

From that fragile beginning, the next significant use of air refueling had to wait until after World War II, when the fledgling Air Force used it to demonstrate a round-the-world flight using B-29s both as tankers and receivers. This mission still used flexible hose, which was grappled onto by the receiver aircraft and winched into place. This was a very inefficient fuel transfer system and could only be used in daytime and in clear skies. As the strategic bomber and the atomic bomb came together, additional range was needed to give the new Strategic Air Command intercontinental range. Starting with KB-29s as tankers, new refueling equipment was designed to handle large fuel flow rates.

A flying refueling boom designed by Boeing Aircraft Company could be maneuvered into a receptacle on the receiver aircraft while the two aircraft were flown in close formation, the tanker in front of and above the receiver aircraft. This concept is still in use today.

The first post World War II tankers were developed from the B-29, the B-50, and the C-97. These were all propeller-driven aircraft and offered limited capability as tankers. In the same years, bomber technology progressed from the propeller-driven B-50 to the six jet-engined B-47 and the eight jet-engined B-52, which is still in use today. The benefits of the jet engine were quickly recognized by the air transport designers and General Curtis LeMay, CINCSAC, and Boeing adapted the Boeing 707 airliner into a jet tanker, the KC-135.

At the outset, the concept of refueling bombers was separate from that of refueling fighters. The KC-135 was optimized for use with the B-52, and Tactical Air Command's fighter refueling requirements were of secondary importance. The decision to optimize the KC-135 for the B-52 also dictated the KC-135 fleet size. The boom and receptacle refueling equipment decision, while good for large aircraft, was less than optimum for fighter aircraft. Air refueling requirements have increased over the years to the point where airlifter and fighter aircraft requirements comprise over half the total air refueling mission of the Air Force. The offload capacity, range, and limited modernization of the KC-135 have not kept pace with the increasing air refueling needs.

The range and offload limitations of the KC-135 were dramatically evident in the 1973 Arab-Israeli war when landing and overflight rights were denied to Military Airlift Command transports. Using this real-world data, Headquarters, Air Force and Strategic Air Command planners outlined to industry the requirements for an aircraft that (1) can handle the offload requirements of large aircraft such as the C-5, (2) are able to deploy tactical fighter units, including some of the deploying unit's cargo, and (3) are compatible with receiver aircraft that use boom and receptacle, as well as receiver aircraft with probe and drogue air refueling equipment.

The two aircraft proposed by industry were the Boeing 747-200 and the Douglas DC-10-30. Both aircraft met the requirements. The choice had to be made on life cycle cost, and a contract was signed in December 1978, with McDonnell Douglas for the DC-10-30 convertible freighter modified for use as a tanker. The major modifications of the DC-10-30CF converting it to a military tanker configuration are:

1. Fitting the lower cargo deck with seven integral fuel cells which add 117,500 pounds of fuel, bringing the total fuel up to 356,000 pounds.

2. Installing a boom operator's compartment in the lower aft fuselage with seated operators rather than the reclining operators found in the KC-135.

3. Fitting an improved air refueling boom and a separate hose-reel and drogue refueling system.

4. Adding an in-flight refueling receptacle to make the tanker itself air refuelable.

5. Increasing the DC-10 cargo handling system capability.

6. Converting the avionics to military standard configuration and adding an airborne tactical air navigation (TACAN) station to aid in airborne rendezvous between tankers and receivers.

7. Eliminating windows as a cost reduction measure.

8. Providing airline passenger configuration for 20 persons with provisions for additional palletized seating.

The capabilities of the new tanker, now called the KC-10, at 590,000 pounds gross takeoff weight and 350,000 pounds of fuel at liftoff, can best be appreciated by comparison with the KC-135. A KC-135, at 290,000 pounds gross takeoff weight and 180,000 pounds of fuel at liftoff, can deliver 100,000 pounds of fuel at 1,000 nautical miles (nm) and return to its base. A KC-10A can deliver a 100,000 pound offload out to 4,300 nm and return, or it can deliver 255,000 pounds out to 1,000 nm and return.

The capabilities of the KC-10 are two to three times that of the KC-135. The challenge for operations planners is to develop employment concepts that take maximum advantage of the KC-10. Mission area analysis is a method that attempts to quantify the contribution of the KC-10 to Air Force operations plans.

CHAPTER II

MULTI-ATTRIBUTE UTILITY MODELS

Air Force Mission Area Analysis is a multi-attribute utility (MAU) computer model adapted from the works of Dr. Thomas L. Saaty and others. They developed an analysis method in which a course of action or a decision can be chosen from among various options by systematically analyzing sub-elements of the various options and by determining how they contribute to the overall effectiveness of each option. The effectiveness of each option is ranked, and the best option can be selected. The benefit of the method is that many sub-elements and options can be handled easily and logically, and the results are quantifiable and can be examined and redefined at any level at any time.

In general, MAU models are developed using five basic steps: (1) breaking the problem into its structured elements, (2) defining element relationships, (3) establishing element boundaries, (4) developing element effectiveness curves, and (5) determining element weights. It is important also to note that this process is iterative and must be redone as new element information becomes known.

The first step is to break the system into its basic elements. The elements are then arranged in a hierarchical structure. The use of scenarios in structuring the model is vital to keeping the problem manageable and realistic. Accordingly, the scenarios must be appropriate to the problem being evaluated. This is a subjective decision based on expert opinion. The remaining steps define how the sub-elements interact and combine to form the total capability of the system. Generally, sub-elements combine in one of three ways:

1. The additive rule. If the various sub-elements of an element independently change the value of the element, then the total worth of the element is the sum of the value of the sub-elements.

2. The multiplicative rule. This rule is used when the value of the element is zero when the value of any one of the sub-elements is zero. In other words, the performance of the sub-elements is linked such that a degrade of one sub-element cannot be overcome by improving the performance of another sub-element.

3. Other combination rules. Other rules may be needed to describe the relationships within the model. One possible combination is an either-or relationship where an element achieves its maximum effectiveness when any one sub-element attains its maximum, but the element achieves its minimal effectiveness only when all sub-elements are at a minimum effectiveness.

The remaining quantitative steps are also iterative and involve developing effectiveness curves and weights for each element. The use of effectiveness curves quantifies the spectrum of effectiveness of each element instead of having a subjective evaluation in terms of acceptable or unacceptable. The most common quantification method is assessment by experts of the element's performance in an environment, in a scenario, or against a design goal. The performance is expressed as a percentage of capability.

The final step in this dynamic process is the determination of the relative importance of each sub-element within a level of the hierarchy. This is called weighting. The purpose is to reflect in the model the reality that not all needs are equal and not all contributions by the elements are the same. Assigning weights depends on the relative influence that changes in the performance of a sub-element have on the performance of the element and on how the sub-elements combine to influence the performance of the element. If the combination rule for the sub-elements is additive, the changes in the sub-elements' performance should be weighted and normalized to the sum of 1.0. If the combination rule for the sub-elements is multiplicative, a rescaling constant may be necessary to insure that the resulting value for the element's performance is compatible with the rest of the model. This is where experience and expertise come into use to refine the model.

Once the model has been developed, it must be validated. There are two types of validation: internal and external. The internal validation consists of examining the variations in weights to determine their effects on the model. A mathematical pair-wise comparison can also be used to insure consistency among weighted elements. This pair-wise comparison is the method recommended by Dr. Saaty.[1]

Dr. Saaty's method establishes the priorities or weights of elements in a decision tree by comparing the elements in pairs against a given criterion. Bookkeeping in this comparison exercise is made easier by using a matrix. The elements to be considered are arrayed on the vertical and horizontal axes (see Figure 1) and then given numerical values to compare their relative importance

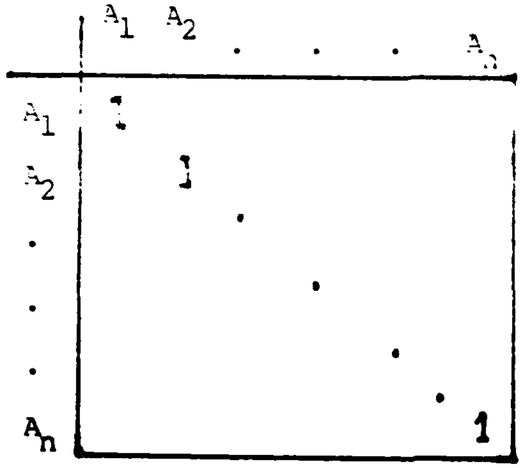

Figure 1. Element Matrix

to each other. The diagonal comparison has a numerical value of one, because the elements are compared to each other. The values below the diagonal are the inverse of the upper half values. Therefore, only the upper half values need to be considered.

After the comparisons have been made, the matrix can be mathematically checked for consistency. Dr. Saaty's method measures the overall consistency of the judgments by means of a consistency ratio.[2] The consistency ratio (CR) should be ten percent or less. If it is more than ten percent, the judgments should be revised. The method involves comparing the actual proper weights to the estimated weights in the pair-wise comparison.[3] Let a, b, c, d . . . n be the actual weights and let (a/b), (a/c), (a/d) . . . (a/n) be the estimated weights in the pair-wise comparison. If n=4 (weights are a, b, c, d), then consider the following:

$$(a/a)a + (a/b)b + (a/c)c + (a/d)d = 4a$$

$$(b/a)a + (b/b)b + (b/c)c + (b/d)d = 4b$$

The remaining two equations for c and d weights are similar. The object then is to solve for a,b,c,d, etc. on the right side of the equation. If the solution is 4 in this case, then the weighting scheme is consistent. If the numerical value of the left side of the equation is equal to the numerical value of the right side, then the weights are absolutely consistent. If the left side is greater than the right side, then some inconsistency exists. The degree of inconsistency can also be compared with the inconsistency values of a random number weighting scheme.

If a set of random numbers were inserted into the matrix in Figure 1, a consistency number can be determined mathematically and is dependent on the size of the matrix. Random consistency values are shown below:

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Consistency	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

This type of process can be computerized and, in fact, has been done by the Air Force. Their system was used to generate the analysis in this research project.

FOOTNOTES

CHAPTER II (Pages 5-9)

[1]Thomas L. Saaty, Decision Making for Leaders (Belmont: Lifetime Learning Publications, 1982), p. 76.

[2]Ibid., p. 82.

[3]Dick Wright, "Multi-Attribute Utility Models," Industrial College of the Armed Forces, Washington, D.C., 27 January 1983.

CHAPTER III

MAA AND THE KC-10

The KC-10 was purchased to provide the Air Force with a large air refueling tanker aircraft that also possesses a limited outsized cargo carrying capability. During proposal evaluation, the source selection committee was hampered by not knowing how the airplane was to be employed. The committee did some trade-off analyses and determined that the airplane should be optimized as a tanker, with cargo carrying as a secondary role. The best proposal was the McDonnell-Douglas DC-10-30 convertible, because it offered the best offload capability and the lowest acquisition costs.

The KC-10 possesses unique strengths and weaknesses when compared with the current Strategic Air Command (SAC) tanker, the KC-135A. This study explores the contribution of the KC-10 to deployment, employment, and resupply of Air Force combat forces. The analysis tool used was mission area analysis (MAA).

As explained in Chapter II, a hierarchical tree was developed and consists of five levels, as shown in Figure 2.

KC-10 MAA Tree

Level	Description
One	KC-10 contribution/capability
Two	Theaters of operations
Three	Types of operations
Four	Forces to be supported
Five	KC-10 performance factors

Figure 2. KC-10 MAA Tree Levels

Each level will be described and analyzed in turn. A diagram of the tree is shown in Figure 3 on page 13.

Level one, KC-10 prioritization, breaks down into two basic areas--air refueling and cargo carrying. The first attempt at quantifying these two areas led to eliminating the KC-10's cargo carrying capability from this analysis because the Air Force does not possess ground support material handling systems to on and offload routine cargo from the KC-10 and other wide body commercial air freighters at forward tactical operational bases. In addition to the on-load/off-load problem, there are currently no airlift operation plans that use the KC-10 solely as a cargo carrier. Therefore, the ability to compare the KC-10's cargo carrying performance against a valid requirement does not exist at present. Headquarters Air Force staff is addressing this deficiency and acquiring additional loading equipment of the type purchased to handle the Civil Reserve Air Fleet. The first level in the KC-10 tree, therefore, had to be reduced to air refueling only.

The second level of the KC-10 MAA tree consists of the theaters of operational use. Different theaters of operation are necessary in the analysis model because air refueling requirements differ in each theater. The theaters in the model were chosen because they are most representative of the global warfighting requirements facing the Air Force. The three theaters selected were Europe (NATO), Southwest Asia, and Korea (Pacific). It is assumed that conventional warfare is taking place in these theaters because the KC-10 is not presently capable of operating in a nuclear electro-magnetic pulse environment. The KC-10 is approximately 80 percent common with the commercial DC-10 and is not hardened against these effects of a nuclear

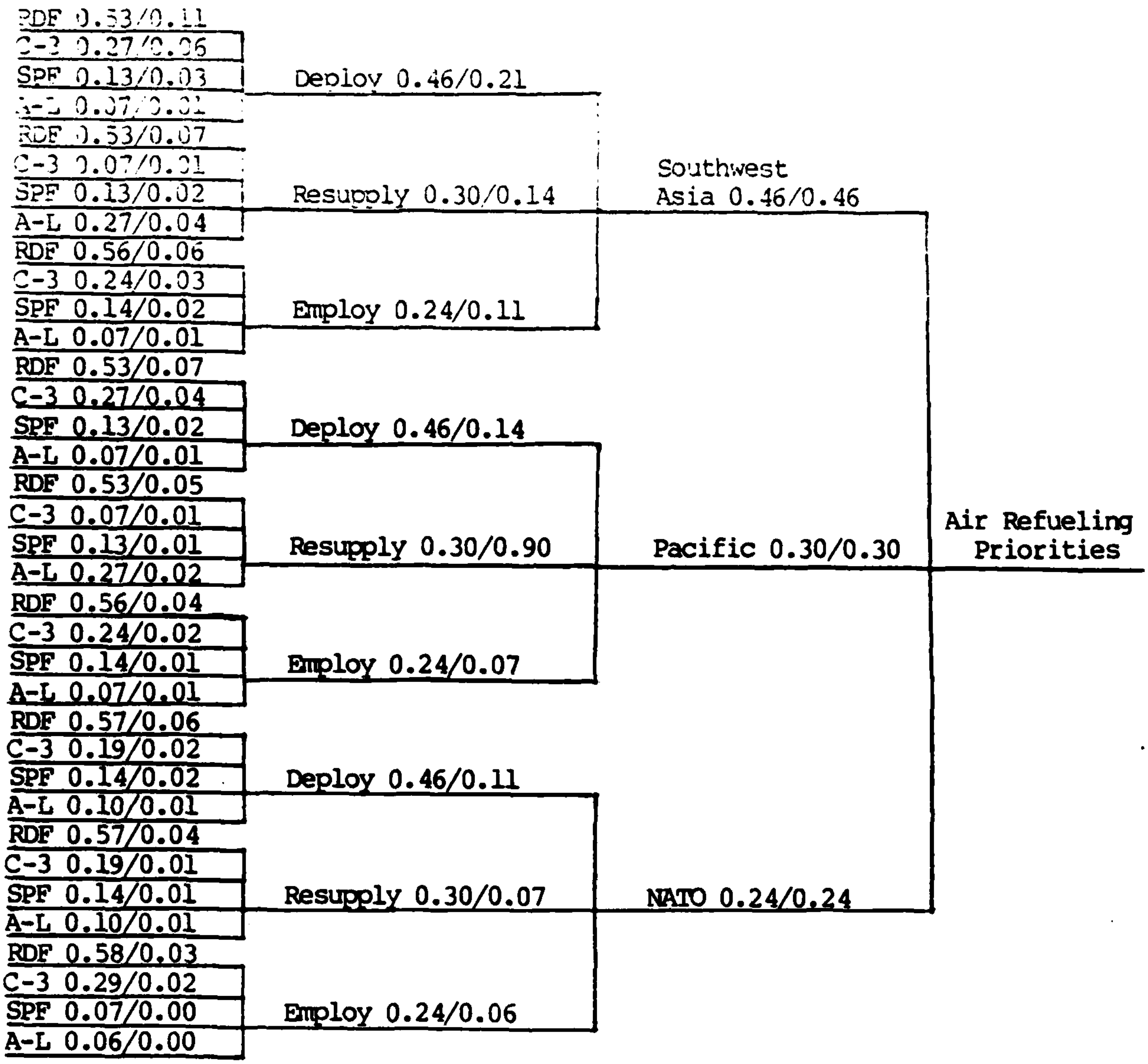

Figure 3. Saaty Weighting Scheme

explosion. For this reason, it is also not presently included in the Single Integrated Operation Plan (SIOP) for waging nuclear war. The first two levels can be summarized as KC-10 air refueling contribution in three representative theaters of operations.

The third level of the tree represents the three operating modes for the KC-10--deployment, employment, and resupply. Thus far the model examines the KC-10's air refueling capability in three theaters and in three modes of operation.

The fourth level of the tree is comprised of the types of receiver aircraft and forces requiring air refueling. In order to limit the size of the analysis, a cross section of receivers and/or forces was used. The Rapid Deployment Force (RDF) represents the CONUS based fighter forces that must be deployed to the three theaters of operation. Because of the number of different types of aircraft, three fighters representing short, medium, and long range performance capabilities were examined. The F-4 Phantom variants are shortest ranged because of their high fuel consumption engines. The F-15, with conformal fuel tanks, was selected as the medium range representative, and the F-111 is the longest ranged fighter. The speed of the computer easily permits other cases to be run, but they would not provide significant insights into the capability of the KC-10. The Strategic Projection Force (SPF) is the B-52H employed in a conventional war. C-3 in the model is the E-3A advanced warning and control system (AWACS). In the airlift portion of the model, both the C-5 and C-141 air refueling requirements were examined. These four levels describe the external environment in which the KC-10 operates.

The fifth, and last, level (not shown) models the internal characteristics of the aircraft. This level has undergone the most change during the several iterations of the model. The changes have been away from a system-by-system model to one that considers only major aircraft systems, such as airframe, engines, avionics, and air refueling systems. This level also factors in maintenance requirements in the form of sorties per day. Because wartime scenarios are being considered, the 12.5 flying hours per day surge rate is considered the limiting factor. The total force of 68 aircraft reflected in the current Air Force planning was used to size the KC-10 fleet. Weather factors and command and control considerations are also elements of this level which combine to form the sortie availability and sortie effectiveness elements of the tree.

As discussed in Chapter II, the next step in building a hierarchical tree is weighting the various elements and determining how they should be combined. This step relies on experience and expert opinion. I accomplished the weighting and element combination problem with the help of Headquarters Air Force personnel and by using my own SAC tanker planning and operations experience. The sum of the node weights across each level must equal 1.00, and in the Air Force MAA process, weighting is a top-down process. The Air Force MAA process will be discussed in the next chapter.

Beginning at the top of the KC-10 tree in Figure 3, level one has only one node and gets an automatic weight of 1.0. The next level is the three theaters and, based on containment of the USSR, they were weighted in order of priority--NATO, Southwest Asia, and Pacific. The main criterion for levels three and four was that maximum benefit from air refueling received the highest weight. Deployment received the highest weight because without air refueling, in many cases, we simply cannot get there from here. Employment and resupply weights were adjusted depending on the theater. It should be noted that the C-5 and C-141 are designed to operate from the CONUS to NATO bases without air refueling. In addition to assigning weights directly, pair-wise comparison was also made, and the weighting results are shown in Appendix A. The weights were assigned using a Saaty computer program developed by NDU Decision Systems Directorate. The results are shown in Figure 3. The first number is the node weight and the second number is the overall level weight. I found that for this simple tree, assigning weights at each node was easier than doing a pair-wise comparison and trying to determine how much more important one element was over another.

The result of Figure 3 is a resource allocation tree that tells how various elements compete for air refueling. The elements with the highest number at each level would receive highest priority. The Air Force Mission Area Analysis takes into account importance, force size, capability, and most significantly, it tells what contribution the KC-10 makes in meeting air refueling requirements.

CHAPTER IV

AIR FORCE MAA: AN APPLICATION

Office of Management and Budget (OMB) Circular Number 109 requires that the cost of a proposed new system be justified based on the contribution it makes to mission accomplishment. In order to comply with OMB 109, a method was needed to quantify the current capabilities and deficiencies, and a hierarchical method was developed, called Mission Area Analysis (MAA). In addition to OMB 109 requirements, development of annual Air Force Program Objective Memorandum required a logical structure to handle the budget allocation among numerous weapons systems and support elements.

Wartime needs drive the Planning, Programming, and Budgeting System (PPBS). Clear objectives and system productivity contributions are needed to make rational decisions which allocate resources in the most cost-effective way. MAA builds an Air Force warfighting tree by examining each warfighting element in the budget to measure limitations and contributions to the warfighting objectives established by the Defense Guidance. The MAA system is a computer-based program developed by the Air Force with the assistance of Anser Corporation.

The KC-10 MAA tree shown in Appendix B was developed using the Air Force MAA computer-generated analysis and simplified for use in this analysis. The tree structure is the same as the one described in Chapter III, but the weighting process was changed from a Saaty pair-wise comparison to a direct process based on experience. Only four levels are shown on the computer printout. The fifth level is sortie capability.

Sortie capability is made up of sorties available and sortie effectiveness. Sorties available is a function of airframe availability and sortie length. The current Air Force objective is to purchase 68 KC-10s. The aircraft is capable of flying 12.5 hours per day for short periods. In my experience, 12.5 hours per day can be achieved only under conditions of very long sortie lengths. However, under surge conditions and with highly reliable systems, ground refueling with one engine running, and other reduced ground time operating procedures, 12.5 hours per day could allow multiple sorties per day. In this analysis, the equation shown in Figure 4 was used.

$$\text{Sorties Available} = \frac{12.5 \times 68}{\text{sortie length}}$$

Sortie Length = average sortie by type of receiver force (SPF, RDF, C-3, etc.) in each theater of operations.

Figure 4. Sortie Capability

The equation in Figure 4 represents the maximum capability of the airplane and must be reduced to a realistic level. The reduction was accomplished using a sortie effectiveness term.

Sortie effectiveness is expressed as a percentage and is comprised of takeoff/landing weather restrictions, en route reliability, navigation and rendezvous reliability, and air refueling reliability. Takeoff and landing restrictions occur in varying percentages, depending on the theater of operations. En route reliability is composed of engine and airframe dependability. Airframe dependability includes avionics, electrics, pneumatics, and hydraulic systems. The dependability percentage is a historical number based on actual operational data. Air refueling reliability comprises weather factors and air refueling systems performance. Experience has shown that weather in the air refueling areas has been adequately compensated for by the flight crews. Therefore, the weather factor is greater than 99 percent and was assumed in this analysis not to degrade air refueling operations. Air refueling systems reliability is also based on historical operational data.

At least one additional sortie effectiveness factor should be considered if assessing the total air refueling mission. That factor is command and control. In this analysis, command and control was not included for two reasons: only the capability of the KC-10 is being evaluated, and command and control systems are only about 50 percent effective, which would skew the results toward an unrealistically low value. The problem with the command and control performance values is that if a mission goes exactly as planned, or if changes are made early enough to have no effect on the actual conduct of the mission, the command and control system is rated at 100 percent effective. Mission changes that do not reach the flight crew in time to avoid impacting the mission are reflected in a lower command and control performance. Historically, 50 percent of the air refueling missions are flown as scheduled. The 50 percent not flown as scheduled are not totally ineffective; they merely are not flown as scheduled. Therefore, when the 50 percent command and control performance is added to the sortie effectiveness factor, the analysis does not accurately model the real world situation. These command and control problems are being addressed by Headquarters Air Force planners.

Sortie effectiveness factors and their numerical values are summarized below in Figure 5.

Factor		Value
Takeoff weather restrictions	NATO	0.15
	Pacific	0.01
	Southwest Asia	0.05
Engine reliability		0.98
Airframe reliability		0.96
Navigation and Rendezvous		0.99
Air Refueling reliability		0.99

Figure 5. Sortie Effectiveness

The next step in the analysis was to determine the KC-10 sorties required to support various types of forces in the three theaters of operations. Sorties required were determined with the aid of a KC-10 computer flight planning model used by Headquarters Air Force/Studies and Analysis. An example of the computer product is shown in Appendix C. The various aircraft in the RDF are represented as short range (F-4 Phantom), medium range (F-15 Eagle), and long range (F-111). The SPF is represented by the long range B-52H, C-3 is the E-3A Sentry, and airlift is comprised of C-5 and C-141 aircraft. The results are expressed in tankers required per unit, and average tanker sortie length for each operations theater and are shown in Figures 6, 7, and 8.

Deployment Tanker Support -- Southwest Asia

Force	Tankers/Unit	Hours/Average Tanker Sortie
RDF (Short)	17/24	5.50
RDF (Medium)	11/24	6.32
RDF (Long)	11/24	7.55
C-3	4/6	3.10
SPF	2/12	4.10
A-L	1/5.25	7.80

Figure 6. Southwest Asia

Deployment Tanker Support--NATO

Force	Tankers/Unit	Hours/Average Tanker Sortie
RDF (Short)	9/24	7.0
RDF (Medium)	5/24	10.14
RDF (Long)	4/24	9.3
C-3	2/6	3.1
SPF	Not req'd	N/A
A-L	Not req'd	N/A

Figure 7. NATO

Deployment Tanker Support--Pacific

Force	Tankers/Unit	Hours/Average Tanker Sortie
RDF (Short)	20/24	9.00
RDF (Medium)	10/24	6.80
RDF (Long)	6/24	10.13
C-3	6/6	14.06
SPF	2/12	5.60
A-L	Not req'd	N/A

Figure 8. Pacific

In using the KC-10 flight plan, the tanker was flown either out of the CONUS and returned to the CONUS, or flown out of a normal tanker forward operating base, such as Hickam, Hawaii, Zaragoza, Spain, or Athens, Greece. This procedure may have caused some increased flying time, but kept the tankers more readily available for repeat daily operations.

After determining the tankers required per unit deployed, a typical major force effort was examined. The most tanker-demanding scenario is the Southwest Asia theater. Deployment and resupply involve the same kinds of tanker operations and were treated as the same in this analysis. Because of the limited number of KC-10s (68 aircraft), KC-135s would be deployed to augment the KC-10 and would most likely provide the bulk of the employment air refueling. Diverting KC-10s from resupply to employment would probably be most feasible after the sea link between the CONUS and the Persian Gulf had been established. Replacing the KC-135 with KC-10s during the employment phase would permit some KC-135s to return to strategic nuclear bomber support, but this would be a real-time decision that is not suitable for advanced analysis. Therefore, only an analysis of the deployment problem is presented here. While only the Southwest Asia theater deployment is examined, the procedures for other theaters would be identical.

The fighting force shown in Figure 9 is representative of the kinds of forces that we would likely deploy to meet a major threat in Southwest Asia. The tanker forces required to support the forces shown in Figure 9 were obtained from Figure 6 on page 21. The average tanker sortie hours were also taken from Figure 6, and the sortie capability values were calculated using the formula in Figure 4 on page 18.

Southwest Asia Forces (Typical)

Forces	Number of Aircraft	Units
RDF (Short)	96	4
RDF (Medium)	96	4
RDF (Long)	24	1
C-3	6	N/A
SPF	12	1
A-L	110 per day	N/A

Figure 9. SWA Combat Forces

To insure that the 12.5 hours/day utilizaton rate was not exceeded. An equivalent tanker value was calculated to account for being able to fly one tanker on multiple sorties per 24-hour day. The equation used is shown below:

$$\text{Equivalent Tankers} = \text{Required Tankers} \times \frac{\text{Average Sortie Length}}{12.5}$$

A maximum of 68 equivalent tankers can be flown per 24-hour day if a perfect command and control system is assumed to exist.

KC-10 Force Requirements (Southwest Asia)

Forces	Required Tanker Sorties per Force	Req'd Equivalent Tankers	Available Equivalent Tankers	Sorties Available
RDF (Short)	68	29.9	29.9	68
RDF (Medium)	44	22.2	22.2	44
RDF (Long)	11	6.6	6.6	11
C-3	4	1.0	1.0	4
SPF	2	0.6	0.6	2
A-L	19.4	12.1	7.7	12
	148.4	72.4	68.0	141

Figure 10. Tankers Required for SWA

For deploying to Southwest Asia, the sortie capability from Figure 10, shown above, is 141 sorties. With the sortie effectiveness factors from Figure 5 applied, the capability is (141 x 0.876) or 123.5 sorties.

The KC-10 refueling MAA tree is shown on pages 25 and 26. The original tree included sea control, but a well-defined operations plan was not available. Sea control is accomplished by B-52 aircraft and could be included as part of the SPF for air refueling purposes. When the tree was modified to eliminate sea control, force weights were evenly redistributed to the other elements at that node. This redistribution accounts for the repeating digit element weights.

The column on the tree labeled "Import" (importance) is the product of that element weight times the product of the node weights above it in the tree. The Southwest Asia (SWA) theater is weighted at 0.400. Because the node above SWA is weighted at 1.00, the importance of SWA is 0.400. The importance of the next level is 0.400 times the individual element weights. For example, SWA Deploy is weighted 0.400, and Deploy importance is 0.400 times 0.400, or 0.16. The importance of the next level elements is therefore 0.16 times the element weight. For example, RDF deploying to SWA is weighted 0.333, and its importance is 0.0533. The remaining two columns are "CP" (capability) and "Need." The Need column is simply importance times 100, to express the results of the tree in a percentage.

Previous calculations, which are summarized in Figure 10 on page 23, showed that all 68 KC-10s would be required to support just one operation, i.e., deployment to SWA. Deployment to SWA represents a need factor of 16, which is the highest operational need value in the tree. The KC-10 is capable of providing 123 sorties, which is 25 sorties short of what is required. Time phasing, or augmentation with KC-135s, would be necessary to complete this operation. Therefore, the capability column for that node would show less than 100 percent, and the shortage would be applied to the element with the lowest importance.

From this initial effort, which is in continual need of refinement and updating, it is easy to see why MAA is an evolving process. But I was able to verify the original KC-10 source selection committee's decision that air refueling is the primary mission, and it appears that the airplane may never run out of air refueling work.

CHAPTER V

CONCLUSION

Mission area analysis/hierarchical decision tree method is a valuable management decision tool. The secret of success as a decision aid lies in the method's reliance on direct input from the commander/manager, rather than being developed by model makers as mathematical simulation of the real world. Mission area analysis seems ideally suited to the air refueling mission because the analysis quantifies the air refueling contribution in combat terms that can be compared directly with desired goals.

In the past, combat support missions, such as air refueling and airlift, could not compete effectively for an appropriate share of the Air Force budget because pounds of fuel delivered, or ton-miles of cargo hauled, did not mean as much to the decisionmakers as did speed, range, turn radius, bomb load, and number of targets destroyed. By using mission area analysis, air refueling can be evaluated for its contribution to combat effectiveness.

I found the method to be simple in its philosophy and complex in its execution. A computer program is advisable to handle the analysis if the decision is not almost "intuitively obvious." In other words, what I thought looked relatively easy, turned out to be very difficult, and I had to reduce the scope of the objectives for this research project.

The analysis proved the KC-10 to be capable of providing sufficient air refueling to deploy forces anywhere in the world. It appears that a 68-airplane KC-10 air refueling force is the minium needed to handle significant deployments. Our command and control system must be strengthened to exploit fully the capabilities of the KC-10. This project only scratched the surface on this subject, and follow-on studies are recommended.

APPENDIX A

SAATY HIERARCHY PROGRAM

```
CP L NDUE0001 E130 NOM
LOGON AT 21:47:12 EST SUNDAY 02/06/83 LINE 6D7 (2-1-0B8)
CMS/SP REL 1 01/25/83 V008
A (191) R/O

YOU HAVE EXPENDED 4% OF YOUR ASSIGNED BUDGET

R;

C/SAATY
B (192) R/O


 SAATY HIERARCHY PROGRAM -- 18 JANUARY 1983


 FREE FORMAT--SEPARATE MULTIPLE VALUES BY COMMAS OR BLANKS
 ENTER RECIPROCALS AS FRACTIONS E.G. TYPE .1666 FOR 1/6
 NO MORE THAN FORTY NODES IN ANY PARTICULAR LEVEL

DO YOU WANT TO PROCESS UNRELATED MATRICES?--(Y/N)
>NO


TYPE YES TO USE SAATY METHOD TO INPUT WEIGHTS
TYPE NO TO INPUT WEIGHTS DIRECTLY

>YES


IS YOUR HIERARCHY COMPLETELY SYMMETRICAL?--(Y/N)
>YES


TYPE THE NUMBER OF NODES IN THE FIRST HIERARCHY LEVEL
?
>1
   1--CORRECT--(Y/N)
>YES
 NODES ON LEVEL  1 ARE NUMBERED FROM  1 TO  1

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>1
    1.00
CORRECT--(Y/N)
>YES

  FOR THIS MATRIX...

 WEIGHTS=      1.000

 EIGENVALUE= 1.000       C.I.= 0.0
                         OR      0.0  AS INCONSISTENT AS AVERAGE MONKEYS
```

```
HOW MANY DISTINCT FACTORS IN LEVEL  2
?
 3
YOU WANT  3 DISTINCT FACTORS IN THIS LEVEL--(Y/N)
>YES
THERE WILL BE  3 NODES ON LEVEL  2
A SET OF  3 ATTACHED TO EACH OF  1 NODES ON LEVEL  1

 NODES ON LEVEL  2 ARE NUMBERED FROM  2 TO  4


LEVEL:  2 MATRIX:  1

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>1.5 2.0
    1.50  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>1.25
    1.25
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.462      0.302      0.236

EIGENVALUE= 3.000       C.I.= 0.000
                        OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS

WANT TO REDO THIS MATRIX?--(Y/N)
>NO

  **  OVERALL IMPORTANCE WEIGHTS FOR NODES AT LEVEL   2
     0.462  0.302  0.236

 ***** OVERALL DISTINCT FACTOR IMPORTANCE WEIGHTS AT LEVEL  2
       0.46   0.30   0.24

HOW MANY DISTINCT FACTORS IN LEVEL  3
?
>3
YOU WANT  3 DISTINCT FACTORS IN THIS LEVEL--(Y/N)
>YES
THERE WILL BE  9 NODES ON LEVEL  3
A SET OF  3 ATTACHED TO EACH OF  3 NODES ON LEVEL  2

 NODES ON LEVEL  3 ARE NUMBERED FROM  5 TO 13
```

```
LEVEL:  3 MATRIX:  1

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>1.5 2.0
    1.50  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>1.25
    1.25
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.462      0.302      0.236

EIGENVALUE= 3.000         C.I.= 0.000
                          OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS
LEVEL:  3 MATRIX:  2

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>1.5 2.0
    1.50  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>1.25
    1.25
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.462      0.302      0.236

EIGENVALUE= 3.000         C.I.= 0.000
                          OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS


LEVEL:  3 MATRIX:  3

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>1.5 2.0
    1.50  2.00
CORRECT--(Y/N)
>YES
```

```
FOR ROW 2:
?
 1.25
    1.25
CORRECT--(Y/N)
 YES

 FOR THIS MATRIX...

WEIGHTS=      0.462      0.302      0.236

EIGENVALUE= 3.000       C.I.= 0.000
                        OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS

WANT TO REDO THIS MATRIX?--(Y/N)
>NO

  **  OVERALL IMPORTANCE WEIGHTS FOR NODES AT LEVEL   3
     0.214   0.139   0.109   0.139   0.091   0.071   0.109   0.071   0.056

 ***** OVERALL DISTINCT FACTOR IMPORTANCE WEIGHTS AT LEVEL  3
       0.46    0.30    0.24
HOW MANY DISTINCT FACTORS IN LEVEL  4
?
>4
YOU WANT  4 DISTINCT FACTORS IN THIS LEVEL--(Y/N)
>YES
THERE WILL BE 36 NODES ON LEVEL  4
A SET OF  4 ATTACHED TO EACH OF  9 NODES ON LEVEL  3

 NODES ON LEVEL  4 ARE NUMBERED FROM 14 TO 49


LEVEL:  4 MATRIX:  1

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>2 4 8
    2.00  4.00  8.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>2 4
    2.00  4.00
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
 2
    2.00
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.533      0.267      0.133      0.067

EIGENVALUE= 4.000       C.I.=-0.000
                        OR    -0.00 AS INCONSISTENT AS AVERAGE MONKEYS
```

```
LEVEL:  4 MATRIX:  2

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>8 4 2
    8.00  4.00  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>.5 .25
    0.50  0.25
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>.5
    0.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.533      0.067      0.133      0.267

EIGENVALUE= 4.000        C.I.=-0.000
                         OR     -0.00 AS INCONSISTENT AS AVERAGE MONKEYS
LEVEL:  4 MATRIX:  3

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>2 4 10
    2.00  4.00 10.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>2 2.5
    2.00  2.50
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>2.5
    2.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.557      0.237      0.139      0.067

EIGENVALUE= 4.061        C.I.= 0.020
                         OR      0.02 AS INCONSISTENT AS AVERAGE MONKEYS
```

```
LEVEL:  4 MATRIX:  4

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>2 4 8
    2.00  4.00  8.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>2 4
    2.00  4.00
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>2
    2.00
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.533      0.267      0.133      0.067

EIGENVALUE= 4.000       C.I.=-0.000
                        OR    -0.00 AS INCONSISTENT AS AVERAGE MONKEYS
LEVEL:  4 MATRIX:  5

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>8 4 2
    8.00  4.00  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>.5 .25
    0.50  0.25
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>.5
    0.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.533      0.067      0.133      0.267

EIGENVALUE= 4.000       C.I.=-0.000
                        OR    -0.00 AS INCONSISTENT AS AVERAGE MONKEYS
```

```
LEVEL:  4 MATRIX:  6

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>2 4 10
    2.00  4.00 10.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>2 2.5
    2.00  2.50
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>2.5
    2.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.557      0.237      0.139      0.067

EIGENVALUE= 4.061        C.I.= 0.020
                         OR     0.02 AS INCONSISTENT AS AVERAGE MONKEYS
LEVEL:  4 MATRIX:  7

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>3 4 6
    3.00  4.00  6.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>1.3 2
    1.30  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>1.5
    1.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=      0.572      0.189      0.144      0.095

EIGENVALUE= 4.000        C.I.= 0.000
                         OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS
```

```
LEVEL:  4 MATRIX:  8

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
 3 4 6
    3.00  4.00  6.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
>1.3 2.0
    1.30  2.00
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
>1.5
    1.50
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=     0.572     0.189     0.144     0.095

EIGENVALUE= 4.000       C.I.= 0.000
                        OR     0.00 AS INCONSISTENT AS AVERAGE MONKEYS
LEVEL:  4 MATRIX:  9

 ENTER THE UPPER TRIANGULAR PART
   FOR ROW  1:
?
>2 8 10
    2.00  8.00 10.00
CORRECT--(Y/N)
>YES
   FOR ROW  2:
?
 4 5
    4.00  5.00
CORRECT--(Y/N)
>YES
   FOR ROW  3:
?
 1.25
    1.25
CORRECT--(Y/N)
>YES

 FOR THIS MATRIX...

WEIGHTS=     0.580     0.290     0.072     0.058

EIGENVALUE= 4.000       C.I.=-0.000
                        OR    -0.00 AS INCONSISTENT AS AVERAGE MONKEYS
```

** OVERALL IMPORTANCE WEIGHTS FOR NODES AT LEVEL 4

0.114	0.057	0.028	0.014	0.074	0.009	0.019	0.037	0.061	0.026
0.015	0.007	0.074	0.037	0.019	0.009	0.049	0.006	0.012	0.024
0.040	0.017	0.010	0.005	0.062	0.021	0.016	0.010	0.041	0.013
0.010	0.007	0.032	0.016	0.004	0.003				

***** OVERALL DISTINCT FACTOR IMPORTANCE WEIGHTS AT LEVEL 4

0.55 0.20 0.13 0.12

ANOTHER LEVEL?--(Y/N)
(NO

CONSISTENCY RATIO OF THE HIERARCHY (C.R.H.) = 0.002
DASD (B/A) RELEASED.
DASD 192 DETACHED
R;

C/LOG
CONNECT= 00:20:58 APPROX CPU=24.24
RDR= 000000 PUN= 000000 PRT= 000000
LOGOFF AT 22:08:14 EST SUNDAY 02/06/83

APPENDIX B

KC-10 MAA TREE

```
SNUMB = 4250I, ACTIVITY # = 01, , REPORT CODE = 52, RECORD COUNT = 000139

HI, I'M THE MAA TREE PROCESSOR.
82-1A VERSION.
DO YOU WISH TO USE AN EXISTING FILE
YES REFUEL
FILE NAME        =LC75A/TREES/REFUEL
ROOT TITLE       =REFUELING KC-10A
CLASSIFICATION   =U
MAXIMUM NODES    =     426
AVAILABLE NODES  =     306
WHAT DO YOU WANT TO DO
DESC 0 8
```

NODE	TITLE	WEIGHT	IMPORT	[illegible]	NEED
1	REFUELING ROLE	1.000	1.000	0.	100.
1, 1	NATO	0.400	0.400	0.	40.0
1, 1, 1	DEPLOY	0.400	0.160	0.	[illegible]
1, 1, 1, 1	SPF	0.	0.	0.	.
1, 1, 1, 2	ROF	0.600	0.960E-01	0.	9.60
1, 1, 1, 3	AIRLIFTERS	0.300	0.480E-01	0.	4.80
1, 1, 1, 4	C3	0.100	0.160E-01	0.	1.60
1, 1, 2	EMPLOY	0.300	0.120	0.0	[illegible]
1, 1, 2, 1	SPF	0.250	0.300E-01	0.	3.00
1, 1, 2, 2	ROF	0.500	0.600E-01	0.	6.00
1, 1, 2, 3	SEA CONTROL	0.	0.	0.	0.
1, 1, 2, 4	AIRLIFTERS	0.	0.	0.	.
1, 1, 2, 5	C3	0.250	0.300E-01	0.	3.00
1, 1, 3	RESUPPLY	0.300	0.120	0.0	12.0
1, 1, 3, 1	SPF	0.	0.	0.	0.
1, 1, 3, 2	ROF	0.444	0.533E-01	0.	5.33
1, 1, 3, 3	SEA CONTROL	0.	0.	0.	0.
1, 1, 3, 4	AIRLIFTERS	0.444	0.533E-01	0.	5.33
1, 1, 3, 5	C3	0.111	0.133E-01	0.	1.33
1, 2	SWA	0.400	0.400	0.	40.0
1, 2, 1	DEPLOY	0.400	0.160	0.	16.0
1, 2, 1, 1	SPF	0.222	0.356E-01	0.	3.56
1, 2, 1, 2	ROF	0.333	0.533E-01	0.	5.33
1, 2, 1, 3	SEA CONTROL	0.	0.	0.	0.
1, 2, 1, 4	AIRLIFTERS	0.222	0.356E-01	0.	3.56
1, 2, 1, 5	C3	0.222	0.356E-01	0.	3.56
1, 2, 2	EMPLOY	0.300	0.120	0.0	12.0
1, 2, 2, 1	SPF	0.250	0.300E-01	0.	3.00
1, 2, 2, 2	ROF	0.500	0.600E-01	0.	6.00
1, 2, 2, 3	SEA CONTROL	0.	0.	0.	0.
1, 2, 2, 4	AIRLIFTERS	0.	0.	0.	0.
1, 2, 2, 5	C3	0.250	0.300E-01	0.	3.00
1, 2, 3	RESUPPLY	0.300	0.120	0.0	12.0
1, 2, 3, 1	SPF	0.111	0.133E-01	0.	1.33
1, 2, 3, 2	ROF	0.333	0.400E-01	0.	4.00
1, 2, 3, 3	SEA CONTROL	0.	0.	0.	0.
1, 2, 3, 4	AIRLIFTERS	0.444	0.533E-01	0.	5.33
1, 2, 3, 5	C3	0.111	0.133E-01	0.	1.33
1, 3	PACIFIC	0.200	0.200	0.	20.0
1, 3, 1	DEPLOY	0.400	0.800E-01	0.	8.00
1, 3, 1, 1	SPF	0.	0.	0.	0.
1, 3, 1, 2	ROF	0.400	0.320E-01	0.	3.20
1, 3, 1, 3	SEA CONTROL	0.	0.	0.	0.
1, 3, 1, 4	AIRLIFTERS	0.400	0.320E-01	0.	3.20
1, 3, 1, 5	C3	0.200	0.160E-01	0.	1.60
1, 3, 2	EMPLOY	0.300	0.600E-01	0.0	6.00
1, 3, 2, 1	SPF	0.250	0.150E-01	0.	1.50
1, 3, 2, 2	ROF	0.500	0.300E-01	0.	3.00
1, 3, 2, 3	SEA CONTROL	0.	0.	0.	0.
1, 3, 2, 4	AIRLIFTERS	0.	0.	0.	0.
1, 3, 2, 5	C3	0.250	0.150E-01	0.	1.50
1, 3, 3	RESUPPLY	0.300	0.600E-01	0.0	6.00
1, 3, 3, 1	SPF	0.111	0.667E-02	0.	0.667
1, 3, 3, 2	ROF	0.333	0.200E-01	0.	2.00
1, 3, 3, 3	SEA CONTROL	0.	0.	0.	0.
1, 3, 3, 4	AIRLIFTERS	0.444	0.267E-01	0.	2.67

APPENDIX C

KC-10 COMPUTER FLIGHT PLANS

E-3 /PACIFIC/ AR #2

RATIO: 1.5/1

E-3A DEPLOYMENT TO MID-EAST

1 E-3A/TANKER

AR #1 over MAINE 70,000 LB

AR #2 OVER GIBRALTER 70,000 LB

SAME A/R SCENARIO USED FOR
BOTH REFUELINGS

B-52H CONUS TO EGYPT

RATIO = 9/1

E-3A TO MIDEAST
3 E-3AA/TANKER

E-3 /PACIFIC/AR #2

RATIO: 1.5/1

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